Enthalpy: Review Questions – Answer Key

1. Q_1 = mc? T

= (454) (0.227) (231.9 - 25)

= + 21 322.7 J

Q_2 = (454) (59.2)

= 26 876.8

? H = $Q_1 + Q_2$

= + 48 199.5 J

= + 48.2 kJ

2. Q_1 = mc? T

= (1000) (2.44) (78.29 – 20)

= 142 227.6 J

= 142.2 kJ

C_2H_5OH = 46g/mol

$\frac{46}{1\,mol} = \frac{1000g}{x\,mol}$

= 21.739 mol

Q_2 = (121.739) (38.56)

= 838.3 kJ

? H = + 981 kJ

3. $?H°_{(rxn)}$ = $?H°_f$ (P) – $?H°_f$ (R)

= $[2(CO_{2(g)}) + 4(H_2O_{(l)}] – [5(O_{2(g)}) + 2(CH_3OH_{(g)})]$

= [2(-393.5) + 4(185.8)] – [0 +2(328.2)]

= - 2586.6 kJ/2 mol of CH_3OH

= - 1293.3 kJ/mol

Or

n mols of CH_3OH = $\frac{m}{Mr}$

= $\frac{0.115}{32}$

$\frac{0.115}{1110}$ = $\frac{32}{xJ}$

? xJ = - 328 kJ

4. Exothermic

n (NO) = $\frac{1.25}{14.01+16}$

= 0.04165 mols

0.04165 ÷ 2 = 0.02083

Q = (? H/mol) (n mol)

= (-114.1) (0.02083)

= -2.38 kJ

5. Endothermic

n (CaO) $= \frac{10}{40.08+16}$

$= 0.1783$ mol

Q $= (464.8)(0.1783)$

$= +82.9$ kJ

6. n (P_4) $= \frac{3.56}{4 \times 30.97}$

$= 0.02874$ mol

Q $= \frac{37.4}{0.02874}$

$= -1\,300$ kJ/mol

$P_{4(s)} + 6Cl_{2(g)} \rightarrow 4PCl_{3(l)}$

$?H°_{rxn} = 4(PCl_{3(l)}) - P_4 - 6(Cl_{2(g)})$

$= 4(-287) - 0 - 0$

$= -287$ kJ/mol

7. -6 534.8 $= [12(-393.5) + 6(-285.8)] - 2?H_f(C_6H_6)$

$?H°_f(C_6H_6) = \frac{12(-393.5) + 6(-285.8) + 6\,534.8}{2}$

$= \frac{98}{2}$

$= +49$ kJ/mol

8. $2Cr_{(s)} + \frac{3}{2}O_2 \rightarrow Cr_2O_{3(s)}$

$2Cr_{(s)} + \frac{3}{2}O_2 \rightarrow Cr_2O_{3(s)} + 11\,397$ kJ

9. $C_{(s)} + 2H_{2(g)} + 1/2O_{2(g)} \rightarrow CH_3OH_{(l)} + 238.7$kJ

10. a) exothermic

b) $6C_{(s)(graphite)} + 6H_{2(g)} + 30_{2\,(g)} \rightarrow C_6H_{12}O_{6(s)} + 1260\ kJ$

11. a) $4C_{(s)(graphite)} + \frac{5}{2}H_{2(g)} + \frac{1}{2}N_{2(g)} + 100.2kJ \rightarrow C_4H_5N_{(l)}$

b) $8C_{(s)(graphite)} + 5\,H_{2(g)} + N_{2(g)} + 200.4\ KJ/mol \rightarrow 2C_4H_5N_{(l)}$

12. Leave equation 1 as is: $P_{4\,(s)} + 10Cl_{2\,(g)} \rightarrow 4\,PCl_{5\,(s)}$ $\Delta H°rxn = -1774.0\ KJ$

Multiply equation 2 by 4: $4PCl_{5(s)} \rightarrow 4PCl_{3(l)} + 4Cl_{2(g)}$ $\Delta H°rxn = -495.2\ KJ$ and reverse

$\Delta H°_{rxn} = 1774.0 + 4(123.8)$

$= -1279\ kJ$

13. Balanced equation: $2SO_{2(g)} + O_{2(g)} \rightarrow 2SO_{3(g)}$

$\Delta H°_{(rxn)} = \Delta H°_f(P) - \Delta H°_f(R)$

$= (2(SO_{3(g)})) - (2(SO_{2(g)})) - (O_{2(g)})$

$= 2(-395.7) - 2(-296.8)$

$= -197.8\ kJ, \therefore$ Exothermic

14. $\Delta H°_{(rxn)} = \Delta H°_f(P) - \Delta H°_f(R)$

$= -395.7 - (-296.8)$

$= -98.9\ kJ/mol, \therefore$ exothermic reaction

$\Delta H°_{(rxn)} = \Delta H°_f(P) - \Delta H°_f(R)$

$= -74.8\ kJ\ mol^{-1} - (-393.5\ kJ\ mol^{-1} + 2(-285.8\ kJ\ mol^{-1})$

$= -74.8\ kJ\ mol^{-1} + 965.1\ kJ\ mol^{-1}$

$= 890\ kJ\ mol^{-1}, \therefore$ endothermic reaction

15. a)

$?H°_{(rxn)} = ?H°_f(P) - ?H°_f(R)$

$= (-1206.9 \text{ kJ mol}^{-1} + (-241.8 \text{ kj mol}^{-1})) - ((-982.5 \text{ kJ mol}^{-1}) + (-393.5 \text{ kJ mol}^{-1}))$

$= -72.7 \text{ kJ mol}^{-1}$, ∴ exothermic

b) $n_{Ca(OH)2} = \frac{1000g}{74.093\ g/mol)}$

$= 13.49655 \text{ mol}$

∴, $Q = (13.49655 \text{ mol})(-72.7 \text{ kJ mol}^{-1})$

$= -981 \text{ kJ}$

16. a)

$?H°_{(rxn)} = ?H°_f(P) - ?H°_f(R)$

$= 0 + 3(-285.8 \text{ kJ mol}^{-1})) - (-842.9 \text{ kJ mol}^{-1})$

$= -857.4 \text{ kJ mol}^{-1} + 842.9 \text{ kJ mol}^{-1}$

$= -14.5 \text{ kJ mol}^{-1}$

b) $n_{WO3} = \frac{1.00\ g}{231.84\ g/mol}$

$= 0.00431 \text{ mol}$

$?H°_{rxn} = (0.00431 \text{ mol})(-14.5 \text{ kJ mol}^{-1})$

$= -0.06235 \text{ kJ}$

$= -62.4 \text{ J}$ ∴ exothermic

17. Given: $?H°_f(Mg(OH)_{2(s)}) = -924.7$ kJ/mol

$?H°_{(rxn)} = ?H°_f(P) - ?H°_f(R)$

$= [Mg(OH)_{2(s)} + H_{2(g)}] - [Mg_{(s)} + 2H_2O_{(l)}]$

$= [-924.7 + 0] - [0 + 2(-285.8)]$

$= -353.1$ kJ/mol or -353 100J/mol

$Q = mc?T$

$Q = (25)(4.18)(3)$

$Q = 313.5$ J

∴ 313.5 J needs to be released

$n = \frac{313.5}{353\ 100}$

$= 0.00088785$ mol of Mg needed

$m = nMr$

$= (0.00088785)(24.31)$

$= 0.02158$g

∴ 0.0216 g of Mg needed.